Collisions with Road Structures and Appurtenances

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Abstract

Commissioned by Finnish National Road Administration the Technical Research Centre of Finland (VTT) made a survey on:

1. The total number of fatal accidents during 1983-86 was collected from the material provided by the Traffic Accident Investigation Boards: Road Guardrails 12, Bridge Railings 7, Lighting Column 18, Portal 1, Electricity Pole 5, Telephone Pole 10, Bridge Pier 8 and the Total 62.

2. A sample of 1000 road kilometres in the Road Districts of Häme and Central Finland, consisting of mainroads was used. The following topics were studied from the sample:

   - the number of guardrail, lighting and other columns and structures
   - the number of collision accidents from the police accident forms
   - the effect of guardrails etc on accidents
   - accident costs FIM/rail metre and FIM/lighting column

The sample included 0,1 fatal + 1,4 injury + 2,4 material damage only accidents per 1000 lighting poles per year as an average.

The results show that breakaway lighting columns are cost-effective on roads with ADT > 1000 vehicles / day.

Developing the structure of guardrails is not nearly as cost-effective a way to reduce accidents as providing bridgepiers with crash barriers or as breakaway lighting columns.

FOREWORD

The accident study was made by Technical Research Centre of Finland commissioned by Finnish National Road Administration. The accident information was collected from police reports and from material of the Accident Investigation Boards. The technical Research Centre also collected data on road structures.

The accident costs were recalculated in National Road Administration for 1990 by using new accident costs figures for each different accident type. The part of the report concerning cost-effectiveness and means of reducing collisions was written by the National Road Administration.

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COLLISIONS WITH ROAD STRUCTURES AND APPURTENANCES

1 NUMBER OF ACCIDENTS AND ACCIDENT COSTS

1.1 Survey

Commissioned by Finnish National Road Administration the Technical Research Centre of Finland (VTT) made a survey on:

1. The total number of fatal accidents during 1983-86 from the material provided by the Traffic Accident Investigation Boards
2. A sample of 1 000 road kilometres in the Road Districts of Häme and Central Finland, consisting of main roads was used. The following topics were studied from the sample:

   - the number of guardrail, lighting and other columns and structures
   - the number of collision accidents from the police accident forms
   - the effect of guardrails etc on accidents
   - accident costs FIM/rail metre and FIM/lighting column

1.2 Results

The full results are published in Finnish by VTT in report: Mäkinen, T. & Roine, M. Törmäämisonnettomuudet tien rakenteisiin ja laitteisiin, VTT Tiedote 1132, Espoo 1990.

Table 1: Fatal accidents in the whole country during three years. (Based on the material of Accident Investigation Boards covering 91 % of all accidents resulting in death).

Type of structure	Number	Type of Accident
Road Guardrails	12	- direct collision with a quardrail (5)
		- against another vehicle after colliding a quardrail on icy road (3)
		- against guardrail after another collision (4)
Bridge Railings	7	- direct collision (3)
		- collision against terminal pier of an old bridge railing (3)
		- against another vehicle after colliding a quardrail (1)
		- against railings after another collision (1)
Lighting Column	18	
Portal	1	
Electricity Pole	5	
Telephone Pole	10	
Bridge Pier	8	- deliberate collision (6)
		- other collision (2)
Total	62	

More information about these accidents is shown in Appendix 1.

Table 2: Accident Cost Caused by Collisions With Guardrail
- the sample contains 266 km of guardrail
- the sample covers 4 years, statistical loss is taken into account
- consists only of cases in which the guardrail has increased damages
- in the sample, an average of 1.7 fatal accidents was caused annually by guardrails per 1 000 guardrail-km. The figure for the whole country on main roads is 0.5, respectively.

ADT	Accident costs caused by guardrails in 20 years per rail metre	
	Value at 1990 Prices	Present Value at a Discount Rate of 6 %
-3000	1055	641
3000 -6000	58	31
6000 -	284	173
Total	356	216 (17.8 per year)

The total includes 1.7 fatal and 42 accidents with injury and 100 accidents with material damage only per 1000 km guardrail annually.

Table 3: Accident Cost Caused By Collisions with Lighting Columns
- the sample contains 4 920 columns
- the sample covers four years, statistical loss taken in to account
- the sample contains only the cases in which the column has increased damages
- the sample had 102 fatal collisions/10^6 column per year. The figure for the whole country on main roads is 83/10^6 column per year, almost the same

ADT	Cost of Collision Accidents in 20 Years Per Lighting Column	
	Value at 1990 Prices, FIM	Present Value at Discount Rate of 6%
-3000	11 349	6 900
3000 -6000	29 662	18 031
6000 -9000	41 693	25 345
9000 -	45 751	27 812
Total	18 333	11 144

The result for ADT 6000-9000 veh/d includes 4.8 fatal, 67 injury, and 100 accidents with material damage annually per 1000 km of road with non-break-away lighting columns on the edge of the road. It has been assumed that there are 20 columns per kilometre.

An example of calculating accident costs is shown in Appendix 2.

1.3 Accident Costs

The following accident costs were used in the above calculations:

- fatal accident	7 550 000	FIM/killed
- accidents resulting in injury	86 000	FIM/injured
- material damage	10 900	FIM/accident

In collisions against lighting columns, accidents resulting in death stood for 84 % of accident costs. In accidents caused by guardrail the figure was 72 %, respectively.

2 REVIEW OF RESULTS

The average accident cost caused by guardrails is 17,8 FIM/meter per year. The value varies a lot. The differences between each traffic volume groups are high and unlogical.

There is one reason to choose a lower accident cost, 8.8 FIM/meter per year. The rate of fatal accidents in the sample is almost three times greater than the rate for the whole country according to the investigation boards of traffic accidents.

It is difficult to determine what part of the damage is caused by the guardrail. In many accidents major damage is caused before crashing the guardrail. In this study it has been assumed that only 20 % of damages in fatal accidents where the car has hit the guardrail are caused by the guardrail. However a higher proportion could have been chosen, as well. By different ways of determining the contributing role of the guardrail one can get 7 to 67 % in the whole country and 33 % in the sample. If 33 % were chosen the average accident cost would be 26 FIM/meter per year.

The accident costs caused by luminair supports that are shown in table 3 are clear and logical. The rate of fatal accidents is about the same as the whole country according to the investigation boards of traffic accidents. It is not difficult to determine which part of the damage is caused by the pole.

3 MEANS OF REDUCING COLLISIONS

The efficiency and economy of the measures to reduce collision accidents are examined below.

3.1 Lighting Columns: 18 fatal accidents/3 years

Table 4 shows that breakaway lighting columns are profitable at least on roads with high traffic volume.

Table 4: Construction costs and collision accident costs (FIM/m)and the sum of costs in brackets. The figures were calculated from 20 years at a rate of interest of 6 % on the basis of Table 3 and there are 20 columns per kilometre. The most economical alternatives are marked with asterix (*).

	Construction cost	Cost of Collision Against Columns		
		ADT 3000	ADT 3000-6000	ADT 6000-9000
Timber columns, overhead cable	120	140(260)*	360(480)	500(620)
Breakaway columns overhead cable	190	40(230)*	90(280)*	130(320)*
Firm metal columns ground cable	300	140(440)	360(660)	500(800)
Breakaway columns ground cable	320	30(350)	70(390)*	110(430)*

The cost of collision of a breakaway column is assessed as about 20..25 % of that of firm columns.

Replacing old firm columns with breakaway columns is often profitable. The investment can be covered by accident cost savings as soon as in 4 years, if the traffic is heavy. Energy-saving lighting can be built at the same time. On narrow roads with low traffic volume it must be examined whether the columns can be placed behind the side ditch.

The number of accidents in the sample are well in conformance with the number of accidents in the whole country.

3.2 Telephone and Electricity Poles: 15 fatal accidents/3 years

According to Appendix 2, the cases are mainly from roads with low traffic volume. Poles shall be placed sufficiently far behind the side ditch unless they are replaced by ground cables. Exceptions are possible, for example inrock cuts.

3.3 Bridge Piers: 8 fatal accidents/3 years

As shown in Table 1 the annual accident costs are as follows:

- all accidents resulting in death: 8 fatality/3 years x 7.55 Million FIM = 20,1 Million FIM a year (c. 251 Million FIM)
- only accidental fatal accidents: 2 fatality/3 years x 7,55 Million FIM = 5,0 Million FIM a year (c. 62 Million FIM)

In brackets the present value of accident costs from 20 years at a rate of interest of 6 %.

There are approximately 300...600 bridges crossing roads with high traffic volume depending on the criterion used. Protecting these structures by crash barriers would cost about 6...12 Million FIM. The sum is returned as savings in accident costs in 2...3 years although injuries and deliberate accidents were omitted.

3.4 Bridgerails: 7 fatal accidents caused by bridgerails/3 years

According to Table 1 the terminal pier at the end of bridgerails is represented in several accidents although such piers exist only in older bridges and only at bridge ends. The dangerousness of terminal piers is due to the fact that the pier most often cuts off the working mechanism of the guardrail. The initial gradient of the rail is also missing in these cases. The railings should be repaired so that the rail would be continuous from the embankment to the bridge. If the terminal pier is preserved, there should be post in the guardrail at an interval of 1 m near the pier.

3.5 Road Guardrails: 8 fatal accidents caused by rail/3 years

Developing the structure of guardrails is not nearly as cost-effective a way to reduce accidents as providing bridgepiers with crash barriers or as breakaway lighting columns.

As shown on Table 2, the present value of collision costs from 20 years at a rate of 6 % is 216 FIM per rail metre. If the accident costs could be halved, a guardrail 108 FIM more expensive (half of 216 FIM) could be financed by savings in 20 years. The cost of constructing today's guardrails is about 120 FIM/km. The problem is treated in details in the Appedix 2.

The sample contained fatal guardrail accidents cleary higher than the rate assumed for the whole country and as a consequence, savings from improved guardrails is anticipated to be lower than mentioned above. On the other hand, the contributing role of quardrails may have been underestimeted in the study by using only 20-25%.

Today's guardrails can be improved by using a spacer between the post and the rail or by reducing the postspacing or weakening the posts.

Technical Research Centre of Finland/
Road and Traffic Laboratory

MATERIAL OF ACCIDENT INVESTIGATION BOARDS FROM 1984-1986

Symbols for accidents studied and a short description

I Lighting Column Accidents

No	of accident	Description
1	VPK 15/86 June 12,1986	Collision against timber pole at curve at high speed, under the influence of alcohol, private road
2	SPK 3/86 April 10, 1986	Motor cyclist colliding with timber lighting column, inexperienced with motorcycle, local road 12885
3	KuPK 6/84 June 3, 1986	Collision with timber lighting column at curve, at 3.25 a.m., two young people, stolen car, Kallantie Kuopio.
4	UPK 18/86 May 24,1986	Collision with timber lighting column in a sharp bend and on wet road, under the influence of alcohol, local road 11455
5	UPK 36/86	Collision with steel lighting column at the end of motorway, wet road, high speed, worn tyres main road 4 (Lahti Motorway)
6	LPK 14/84 October 30,1984	Collision with timber lighting column at intersection, sludge, main road 21
7	LPK 8/84 June 20, 1984	Collision with two timber lighting columns at curve, high speed, alcohol, at 2.00 a.m., passenger died, no safety belt, main road 5
8	SPK 4/84 March 5, 1984	Running off the road with timber lighting column, slippery road, dark, lighted road, under the influence of alcohol, road 265
9	OPK 4/84 May 14, 1984	Collision with timber lighting column in slight bend, driver fell asleep, at 11.50 p.m. no safety belt, main road 4
10	UPK 15/85 May 9, 1985	Collision with timber lighting column in sharp bend, high speed, alcohol, at night, local road 11511
11	UPK 3/85 January 13,1985	Collision with lighting column in central reserve, Ring Road III of Helsinki, high speed, slippery road, alcohol, at 2.12 a.m., main road 50
12	UPK 1/85 January 1,1985	Running off the road due to illness at slight bend, collision with lighting column, no safety belt, road 1141
13	PK 11/86 August 13,1986	Object on the road caused collision with timber lighting column, death of the driver
14	UPK 8/86 April 4,1986	Collision with metal lighting column on Porvoo Motorway, driver' s disposition to doze, column 4 metres from edge line, main road 7

15	KPK 15/85 July 27,1985	Overtaking at curve, contact of vehicles and vaulting with timber lighting column, high speed, at 3.00 a.m., main road 12
16	KPK 14/85 July 25,1985	Loss of control after curve, collision with metal lighting column on the street, column cut off, alcohol, at 0.55 a.m., main street in Lappeenranta.
17	OPK 7/85 May 12,1985	Intersection accident, collision to a motor cycle vaulting into a timber lighting column, main road 22
18	UPK 8/85 February 16,1985	Sliding in a slight bend and collision with timber lighting column, driver fell asleep, main road 53

II Telephone Pole Accidents

No		Description
1	SPK 25/86 November 2,1986	Sliding into a telephone pole downhill, slight bend, dark, slippery road, passenger died, road 2449
2	KPK 13/86 July 13, 1986	Collision with timber telephone pole in a bend, high speed, no safety belt on, highway 384
3	KuPK 11/86 August 17,1986	Collision with timber telephone pole by rally car on gravel road, sharp bend, at 00.03 a.m., passenger with no safety belt on died, local road 16183
4	MPK 14/86 October 11,1986	Collision at high speed with timber telephone pole, slight bend, gravel road, private road
5	UPK 21/86 July 2,1986	Collision with timber telephone pole at 0.35 a.m., driver fell asleep, under the influence of alcohol, no safety belt on, main road 4
6	UPK 24/86 July 13,1986	Collision at slight bend with timber telephone pole, under the influence of alcohol, no safety belt on, road 149
7	UPK 28/86 August 11,1986	Collision with timber telephone pole at curve at 9.25 p.m., under the influenfce of alcohol, high speed, inexpe-rienced, road 107
8	SPK 19/86 September 29,1986	Saw a vehicle run off the road, tried to brake down, run off the road and collided with timber telephone pole, slippery road, main road 3
9	KuPK 08/85 August 9,1985	Collision with timber telephone pole on straight road section, no driver' s licence, 17 years old, at 04.10 a.m., local road 16194.
10	KsPK 14/85 October 5,1985	Collision with a stone, vaulting into a pole support, high speed, under the influence of alcohol, gravel road, 6007.

III Electricity Pole and Portal Accidents

No		Description
1	KPK 22/86 December 8,1986	Collision with metal railway electricity pole at curve, under the influence of alcohol, high speed, at 01.04 a.m., road 3544
2	UPK 23/85 June 9,1985	Sliding into timber electricity pole after heart attack, Nupurilantie , road 118
3	U 12/84 June 16,1984	Sliding into electricity pole at curve, at 2.20 a.m., young people, under the influence of alcohol, no safety belts on, road 109
4	VPK 13/86 June 5,1986	Collision with the cable of timber electricity pole and stone, driver fell asleep, passenger died, main road 8
5	OPK 3/84 May 11,1984	Intersection accident, ending at the portal, Oulu city area

IV Bridge Pier Accidents

No		Description
1	SPK 21/86 October 4,1986	Collision with bridge pier of grade separation, obvious, suicide, main road 8
2	PK/P-K 3/86 May 1, 1986	Collision with pier of overpass at slight bend under the influence of alcohol, high speed, main road 6
3	UPK 51/86 November 13,1986	Collision with bridge pier at slight curve, deliberate action, Porvoo Motoray, main road 7
4	UPK 35/86 August 26,1986	Collision with bridge pier at curve, obvious suicide, under the influence of alcohol, Porvoo Motorway, main road 7
5	SPK 15/84 November 10,1984	Collision with bridge pier at night, under the influence of alcohol, tiredness, road 211
6	SPK 7/85 July 1,1985	Collision with bridge pier of grade separation under the influence of alcohol, main road 2
7	SPK 3/85 April 8, 1985	Sliding into bridge pier of grade separation, deliberate action, main connecting road 42
8	KPK 5/85 April 9,1985	Collision with bridge pier, obvious suicide, main road 6
9	HPK 44/86 June 2,1986	Collision with bridge pier, obvious suicide, main road 4

V Guardrail Accidents

No	Description	
1	UPK 22/85 June 1, 1985	Vaulting from guardrail into concrete terminal pier of bridgerail, driver fell asleep, at 3.10 a.m., main road 1
2	UPK 47/86 October 24,1986	Collision with bridgerail under slippery conditions vaulting with concrete terminal pier of bridgerail, main road 4 (Lahti Motorway)
3	KPK 20/84 December 6,1986	Collision with bridgerail, four lane section, high speed, under the influence of alcohol, at 10.46 p.m., main road 15
4	PK 2/85 February 25,1985	Collision with bridgerail, vaulting into on coming freight truck, slippery road, main road 3
5	U 27/84 October 25,1984	Collision with guardrail at curve, high speed at 01.27 a.m., under the influence of alcohol, road 11490
6	VPK 11/84 November 29,1984	Collision at slight bend first with guardrail then into oncoming freight truck and finally into guardrail, slippery icy road, after overtaking, road 667
7	UPK 32/84 November 29,1984	Collision at local road intersection with turning vehicle and finally into concrete co-lumn of guardrail, main connecting road 53
8	U 28/84 November 13,1984	Head on narrow bridge, one vehicle through guardrail into river, drowned, road 1401
9	UPK 9/86 April 5,1986	Collision with timber railings on bridge, under the influence of alcohol, young motor cyclist, at 10.30 p.m., private road
10	UPK 40/85 February 19,1986	Head on accident ending by guardrail at intersection, icy road, uphill, main road 3
11	UPK 42/86	Collision with end of guardrail, vaulting down the September 21,1986embankment, driver fell asleep, uphill, main road 3
12	UPK 39/86	Intersection accident, ended by guardrail, Ring Road III September 12,1986of Helsinki, main connecting road 53
13	UPK 4/85 February 1,1985	Head on accident under slippery conditions, collision with concrete post of metal guardrail, main road 1
14	HPK 22/86 January 19,1986	Collision at curve on slippery road with guardrail, vaulting backwards into the front of freight truck, the board suggested that guardrail be removed, road 347
15	KPK 24/85 December 11,1985	A towing vehicle sliding into timber guardrail on slippery road, removal of timber guardrail suggested, main road 6

16	HPK 8/85 October 23,198	Attack of illness after overtaking, collision with central guardrail of motorway, vaulting over the rail and turning over on the road, no safety belt on, main road 3
17	HPK 21/85 HPV 23/85 January 29,1985	Loss of control on straight snowy road at bridge collision with metal bridge railings from which with oncoming freight truck, main road 3
18	HPK 28/85 September 20,1985	Motor cycle sliding on wet road into metal guardrail, curve, at 2.25 a.m., main road 58
19	HPK 27/84 April 13,1984	Hitting guardrail after overtaking, no certainty of the role of guardrail, main road 9
20	LPK 3/84 April 25,1984	Collision with concrete terminal pier of bridgerail, narrow bridge, at 5.55 a.m., road 9471

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ACCIDENT COSTS OF GUARDRAILS

The cost of guardrail accidents (accidents/rail metre/20 years) was calculated as follows:

1. Fatal accidents

There were six fatal accidents where a vehicle had hit a quardrail during the period in which seven persons were killed. In five accidents were a vehicle collided with another vehicle before hitting the quardrail and one running-off the road accident. In the latter, the guardrail contributed to the death of one person. In addition, one guardrail accident in which the rail had obvious effect is missing from statistics of the investigation boards of traffic. Two people were killed in this accident (sliding under slippery conditions at a curve with guardrail and vaulting into oncoming vehicle on the opposite lane).

The effect of chance in the fatality figures given is high. If the case omitted from statistics is not taken into account, guardrails contributed in 14 % of the number of persons killed (= (7-6)/7 x 100). The figure for the whole country in the material of the investigation boards during 1984-86 is 7 %, respectively.

When the case omitted from statistics is taken into account (two persons killed) the contributing role of guardrails grows up to 33 % (= 9-6)/9 x 100). The average of the two percentages (7 % of the investigation boards and the revised 33 % of districts) is 20 %. The use of 20 % is justified as the actual role of guardrails in fatalities seems to vary slightly around this figure.

Calculation parametres:

1) number of people killed in collisions with guardrails = 9
2) contribution of guardrails = 20 % (= coefficient 0,2)
3) total length of guardrails = 265 833 m
4) accident period = 4 years
5) study period = 20 years
6) cost of fatal accidents (1 killed) = 7 550 000 FIM

Fatal accidents in 20 years/rail metre:
0,2 x 9/265 833 x 1/4 = 0,000001693 (fatal acc./rail m/year);
20 x 0, 000001693 = 0, 0000339 (fatal accidents in 20 years);
0, 0000339 x 7 550 000 = 255,61 FIM/m/20 years

2. Accidents resulting in injury

There were 56 injured of whom 14 were injured in accidents where guardrails cannot be considered as contributing to the accident. These accidents were either meeting accidents or intersection accidents in which vehicles collided side to side.

The contributing role of guardrails can thus be calculated as follows: (56-14)/56 x 100 = 75 % and the coefficient is 0,75.

Calculation parametres:

1) number of people injured in collisions with guardrails = 56
2) contributing role of guardrails = 75 % (=coefficient 0,75)
3) total length of guardrails = 265 833 m
4) accident period = 4 years
5) study period = 20 years
6) coefficient for revising statistical loss = 1,08
7) cost of accident resulting in injury (1 injured) = 86 800 FIM

Accidents resulting in injury in 20 years/rail metre:
0,75 x 56/265 833 x 1/4 x 0,8 = 0,00004266 (injury acc./rail-m/year),
20 x 0,00004266 = 0,0009 (injury accidents in 20 years),
0,0009 x 86 800 = 74,06 FIM/m/20 years

3. Accidents resulting in material damage

In assessing only such material damages in which the vehicle has collided with guardrail, the contributing role of guardrail is not at all easy to estimate.

When all collisions with guardrails in the districts of Häme and Central Finland resulting only in material damages are examined, it is found that the preceding situation was running off the road in 67 % of all cases. All damages in these accidents were caused by collision with guardrail.

In the remaining 33 % of cases it is difficult to assess the role of guardrails accurately, although it may be assumed that in head on and side-to-side accidents guardrails contribute much less than in collisions of two vehicles. Such accidents stand for 11 % of all cases. The remaining 22 % are cases in which it is problematic to estimate the contribution of guardrails even roughly. The margin of error can be assumed to be largest in about one-fifth of collision accidents resulting in material damages.

The contributing role of guardrails in material damages is emphasized according to the preceding situation as follows:

- Running off the road cases (no other vehicle), coefficient = 1, the share of accidents 67 %
- other accidents, coefficient = 0,20, share of accidents 33 %

The coefficient of the contributing role of guardrails in material damages in all accident types is obtained as follows:

1) total number of accidents = 89
2) share of running off the road cases (collision with guardrail only) = 0,6714 x 89 = 60
3) other accidents 89-60 = 29; in these cases guardrails stand for 0,20 and the number of accidents = 0,20 x 29 = 5.8,
4) coefficient = (60 + 5,8)/89 = 0,74.

Calculation parametres:

1) number of collision accidents with guardrails (material damages) = 89
2) contributing role of guardrails = 74 % (coefficient 0,74),
3) total length of guardrails = 265 833 m
4) accident period = 4 years
5) study period = 20 years
6) coefficient for revising statistical loss = 1,9
7) cost of accidents resulting in material damage = 10 900 FIM

Accidents resulting in material damage in 20 years/rail-m: 0,74 x 89/265 833 x 1/4 x 1,9 = 0,0001 (material dam.acc./rail-m/year), 20 x 0,0001 = 0,0024 (accidents res.in mat.damage in 20 years),
0,0024 x 10 900 = 25,63 FIM/m/20 years.

4. Total of guardrail accident costs

A Fatal accidents 255,61 FIM
B Accidents resulting in injury 74,06 FIM
C Material damages 25,63 FIM
TOTAL355,30 FIM/rail-m per 20 years

ACCIDENT COST OF LIGHTING COLUMNS

Lighting column accident cost (accidents/column/20 years) was calculated as follows:

1. Fatal Accidents

There were two fatal accidents during the study period (1983-86) in which two people were killed. Hitting the column had a decisive importance in injuries resulting in death.

Calculation parametres:

1) number of killed in collisions with lighting columns = 2
2) contributing role of columns = 100 % (coefficient 1,00),
3) total number of columns = 4 920
4) accident period = 4 years
5) study period = 20 years
6) cost of fatal accident (1 killed) = 7 550 000 FIM

Fatal accidents in 20 years/column:
2/4920 x 1/4 = 0,0001 (fatal acc./column/year),
20 x 0,0001 = 0,0020 (fatal accidents in 20 years),
0,0020 x 7 550 000 = 15 345,52 FIM/m/20 years.

2. Accidents Resulting in Injury

There were 36 persons injured in collisions with lighting columns. The number of injured in sliding with the column (without another vehicle) in these accidents was 26 persons (72 %).

The remaining 10 persons were most obviously injured as a result of two vehicles colliding in head on, side to side and rear-end-collisions (one rear-end-collision).

The coefficient describing the role of columns in the consequences of accidents is : (36-10)/36 = 0,72.

Calculation parametres:

1) number of persons injured in collisions with columns = 36
2) contributing role of columns (coefficient) = 0,72
3) total number of columns = 4 920
4) accident period = 4 years
5) study period = 20 years
6) coefficient for revising statistical loss = 1,08
7) cost of accident resulting in injury (1 injured = 86 800 FIM)

Accidents resulting in injury in 20 years/column:
0,72 x 36/4920 x 1/4 = 0,0014 (injury acc./rail-m/year),
20 x 0,0014 = 0,0284 (injury accidents in 20 years),
0,0284 x 86 800 = 2 469,35 FIM/m/20 years

3. Accidents Resulting in Material Damages

Running-off-the road accidents stood for 83 % of all accidents in which only material damages were caused by collision with lighting columns (data districts of Häme and Central Finland from 1983-86). In these cases, damages were caused only by collisions with lighting columns.

The remaining cases were mostly (five accidents) collisions of two vehicles in turning situations (one rear-end-collision) at rather low speed. In these accidents damages caused by columns were obviously clearly less than those caused by the first impact. The contributing role of columns in these cases is estimated at 20 %.

The contributing role of columns in material damages is emphasized according to the preceding situation as follows:

- Running-off-the road cases (no other vehicle), coefficient = 1, the share of accidents 83 %
- other accidents, coefficient = 0,20, share of accidents 17 %

The coefficient for the contributing role of columns in material damages in all accident types is obtained as follows:

1) total number of accidents = 29
2) share of running-off-the road cases (collision with column only) = 0,83 x 29 = 24,
3) other accidents 29-24 = 5; in these cases columns contributed by 0,20 and the number of accidents = 0,20 x 5 = 1,
4) coefficient = (24 + 1)/29 = 0,86.

Calculation parametres:

1) number of collision accidents with columns (material damages) = 29
2) contributing role of columns = 86 % (coefficient 0,86),
3) total number of columns = 4 920,
4) accident period = four years
5) study period = 20 years
6) coefficient for revising statistical loss = 1,9,
7) cost of accident resulting in material damage = 10 900 FIM

Accidents resulting in material damage in 20 years/column: 0,86 x 29/4920 x 1/4 x 1,9 = 0,0024 (mat.dam.acc./column/year),
20 x 0,0024 = 0,0482 (mat.dam.acc.in 20 years),
0,0482 x 10 900 = 524, 90 FIM/m/20 years

4. Total Cost of Lighting Column Accidents

A. Fatal accidents	15 345,52 FIM
B. Accidents resulting in injury	2 469,35 FIM
C. Material damages	524,90 FIM
TOTAL	18 339,77 FIM

FINNISH NATIONAL ROAD ADMINISTRATION

GUARDRAILS USED IN FINLAND

Dimensions of the Finnish guardrail are shown in specification Ty 3/51.

The postspacing is normally 4 metres. The posts are driven into the ground by pressing, which is cheaper than digging a hole and compacting the soil around the post. For this reason stiff steel posts are used, the profile is 60/160/60x6 mm. Stiffness is also needed because snow ploughing causes heavy loads with the guardrail, however, a 60/120/60x5 mm profile may be enough. No spacer is used between post and rail.

The steel thickness in rails is 5 mm on motorways and 4 mm on other roads. Old 3 mm thick steel rails are often damaged by snow ploughing. The width of the rail is 230 mm. This does not cause drifting as much as a rail 300 mm wide. (In Northern Sweden they use a rail 6 mm thick and 170 mm wide for the same reasons.)

The Finnish guardrail is made of 12 metres long railprofiles. Lap joints can not be used between the rails when the steel thickness is more than 3 mm, that is why a joint piece is needed. The installing of 12 m rails is somewhat quicklier than 4,3 m rails with lap joints.

The construction cost of the guardrail is 124 FIM/m in the average.

Theoretically this kind of safety fence is poor, if we think of performance in collision. Snagging is possible when a stiff post and long postspacing is used.

The accident study shows, however, that the number of fatal accidents caused by snagging can not be greater than 5 per 3 years in the whole country.

Besides there are 3 fatal accidents per 3 years where car hits another car after hitting the guardrail. These three accidents have happended on icy roads. Thats why improvement of maintenance is a more promising way to deminish this type of accidents than improving the guardrail.

The possible ways of reducing snagging are:

1. Reduce the postspacing from 4 m to 2 m and use a weaker post (60/120/60x5 mm) with a spacer. This kind of fence is common in USA.

   The construction cost will be 52 % (65 FIM/m) higher than normal guardrail used in Finland. The difference will be 72 % (90 FIM/m) higher if the widening cost of embankment is included.

   If we assume that 50 % of the accident costs caused by guardrails are caused by snagging we can calculate the cost effectiveness of the improvement as follows. The accident cost caused by snagging is 108 FIM/m in 20 years by using an interest rate of 6 %. If we want that the higher construction cost could be saved in accident costs in 20 years the propability and accident costs of snagging accident should be at least 60 % lower with the improved fence than with the normal guardrail.

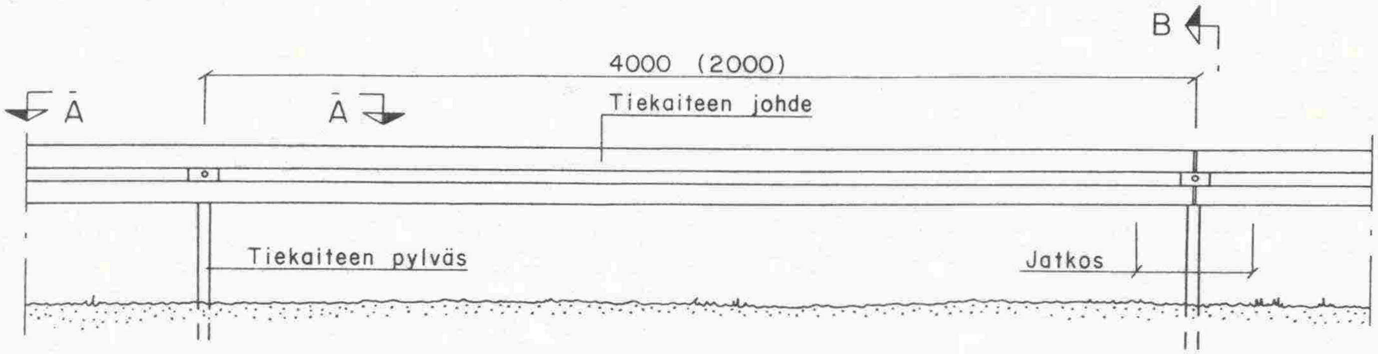
2. Postspacing is 4 metres and a spacer is used between post and rail.

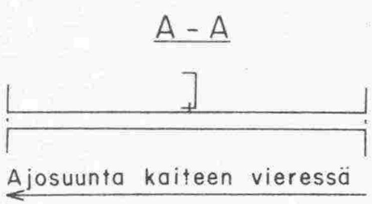
   The consruction cost will be 10 or 30 % (13 or 38 FIM/m) higher than with normal guardrail. In this case the accident costs caused by snagging should be 12 % or 35 % lower than with normal guardrails.

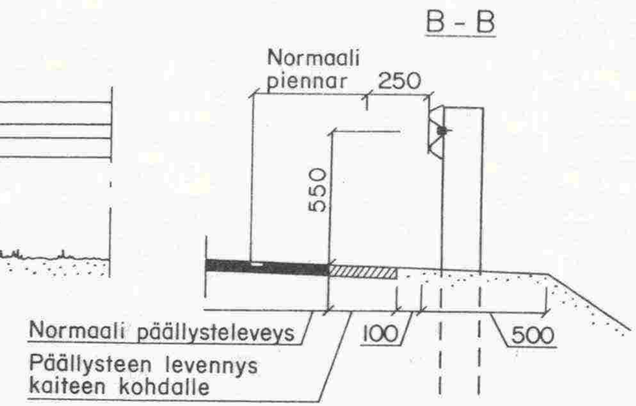
3. Use a weak post (50/100/50x5 mm) and 4 m postspacing.

   Additional consruction cost is caused by more expensive way of installing. Drilling is needed, the post can not be driven down. There will be also higher maintenance costs because the weak posts can not stand the snow ploughing load as well as the normal guardrail. More room is needed between the safety fence and dangerous obstacles than with current standards of guardrail.

As one can see above the improvements in the Finnish guardrail are not very cost effective. The use of breakaway or deformable luminair supports is much more cost-effective way of reducing accidents in Finland.







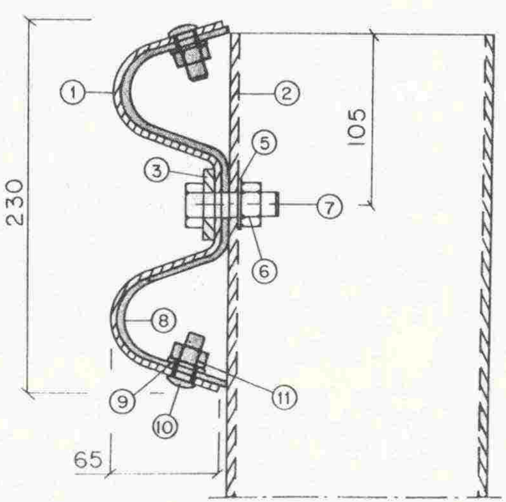
Tiekaiteen aloitus ja lopetus on esitetty tyyppipiirustuksessa Ty 3/52

Suunnitelmassa voidaan esittää tästä poikkeavia mittoja

OSAT	
Johde	① 230/4[1] L=8000 tai 12000
Pylväs	② U-60/160/60×6 L=1800[2]
Tarvikkeet	③ Välilevy 45×120×6 (1 kpl/liitos) ④ Aluslaatta 50×50×4 (0...3kpl/liitos)[3] ⑤ Aluslaatta 18 (1 kpl/liitos) ⑥ Kuusiomutteri M16 (1 kpl/liitos) ⑦ Kuusioruuvi M16×50 (1 kpl/liitos) ⑧ Sidelevy 226/4[1] L=470 (1 kpl/jatkos) ⑨ Aluslaatta 14 (8 kpl/jatkos) ⑩ Lukkoruuvi M12×30 (8 kpl/jatkos) ⑪ Kuusiomutteri M12
MATERIAALI (Fe 37 B)	
Pinnoite (kuuma-sinkitys)	- Johde Znk 420 (60 μm) - Pylväs Znk 500 (70 μm) - Tarvikkeet Znk 375 (55 μm)

1) Silloilla, moottoriväylillä ja erikseen määrätyissä kohdissa on johteena osa ⓑ 232/5 ja sidelevynä osa 8b 226/5.
2) Työselityksen vaatimissa paikoissa osa 2b L = 2200

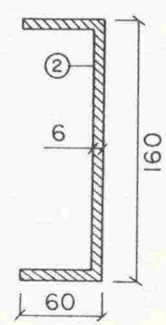
JOHTEEN KIINNITYS PYLVÄÄSEEN



Tarvikkeet jatkoksen kohdalla.

3) Liitoksessa, joka ei ole jatkos, osan ⑧ paikalle tulee 1...2 osaa ④ ja osan 8b paikalle 2...3 osaa ④ siten, että johteesta tulee suora.

PYLVÄS



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